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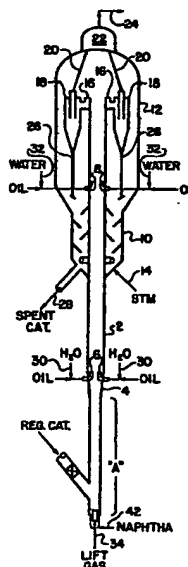
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**(54) Method and apparatus for converting oil feeds.**

**57** Novel riser reactor design with associated multiple feed inlet means for contacting regenerated catalyst particles with low quality naphtha,  $C_5$  minus wet gas product of hydrocarbon conversion and a residual oil feed comprising components boiling above about 1025°F and comprising metal contaminants. Low quality naphtha from thermal cracking is charged either separately or in admixture with  $C_5$  and lower boiling wet gas product of hydrocarbon conversion to the bottom portion of the riser conversion zone for contact with freshly regenerated zeolite cracking catalyst. The vaporous material thus charged conveys the regenerated catalyst at an acceptable velocity to an expanded section of the riser wherein residual oil is charged by a plurality of nozzle means penetrating the wall of the riser in the transition section to the expander user section. A suspension of hydrocarbon vapors and catalyst particles is then passed through the riser discharge for a desired contact time before separation by ballistic separation with a cup about the riser upper to the riser end.



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METHOD AND APPARATUS FOR CONVERTING OIL FEEDSBACKGROUND OF THE INVENTION

5           Crude oils from which desired gaseous and  
liquid fuels are made contain a diverse mixture of  
hydrocarbons, sulfur and nitrogen compound and metal  
contaminants. The hydrocarbon compounds vary widely in  
molecular weight and therefore boil over a wide range.  
10   For example, crude oils are known in which 30 to 60% or  
more of the total volume of oil is composed of compounds  
boiling at temperatures above 650°F. Among these are  
crudes in which from about 10% to about 30% or more of  
the total volume consists of compounds so heavy in  
15   molecular weight that they boil above 1025°F or at least  
will not boil below 1025°F at atmospheric pressure.

          Because these high boiling components of crude  
oil boiling above 650°F are unsuitable for inclusion in  
20   gasoline and some higher boiling liquid hydrocarbon  
fuels, the petroleum refining industry has developed  
processes for separating and/or breaking the molecules of  
the high molecular weight, high boiling compounds into  
smaller molecules which do boil over an appropriate  
25   boiling range. The cracking process which is most widely  
used for this purpose is known as fluid catalytic  
cracking (FCC). Although the FCC process has reached a  
highly advanced state, and many modified forms and  
variations have been developed, their unifying factor is  
30   that a very restricted boiling range hydrocarbon  
feedstock is preferably caused to be cracked at an  
elevated temperature in contact with a cracking catalyst  
that is suspended in the feedstock under cracking  
conditions in a temperature range of 950° to about  
35   1100°F. Upon attainment of a desired degree of molecular

weight and boiling point reduction the cracking catalyst is separated from the obtained hydrocarbon vaporous conversion products.

5. Crude oils in the natural state contain a variety of materials which tend to have quite troublesome effects on FCC processes; and only a portion of these troublesome materials can be economically removed from the crude oil. Among these troublesome materials are  
10 coke precursors (such as asphaltenes, polynuclear aromatics, etc.), heavy materials (such as nickel, vanadium, iron, copper, etc.), lighter metals (such as sodium, potassium, etc.), sulfur, nitrogen and others. Certain of these, such as the lighter metals, can be  
15 economically removed by desalting operations, which are part of the normal procedure for pretreating crude oil for fluid catalytic cracking. Other materials, such as coke precursors, asphaltenes and the like, tend to break down into coke during the cracking operation, which coke  
20 deposits on the catalyst, impairing contact between the hydrocarbon feedstock and the catalyst, and generally reducing its potency or activity level. The heavy metals transfer almost quantitatively from the feedstock to the catalyst surface.

25

If the catalyst is reused again and again for processing additional feedstock, which is usually the case, heavy metals in the feedstock can accumulate on the catalyst to the point that they unfavorably alter the  
30 composition of the catalyst and/or the nature of its catalytic effect upon the feedstock. For example, vanadium tends to form fluxes with certain components of commonly used FCC catalysts, lowering the melting point

of portions of the catalyst particles sufficiently so that they begin to sinter and become ineffective cracking catalysts. Accumulations of vanadium and other heavy materials, especially nickel, on the catalyst act as a  
5 poison in some environments. They tend in varying degrees to promote excessive dehydrogenation and aromatic condensation, resulting in excessive production of carbon and gases with consequent impairment of liquid fuel yield. An oil such as a crude or a high boiling crude  
10 fraction or other source oil that is particularly abundant in metal contaminants such as nickel and/or other metals exhibiting similar behavior, while containing relatively large quantities of coke precursors, is referred to herein as one comprising  
15 metallo-organic compounds or as a carbometallic oil, and represents a particular processing challenge to the petroleum refiner to yield desired products such as gasoline, gasoline precursors and light cycle oils.

20           There has been a long standing interest in the catalytic conversion of carbometallic oils into gasoline and other liquid fuels. For example, in the 1950's it was suggested that a variety of carbometallic oils could be successfully converted to gasoline and other products  
25 in the Houdresid process. The Houdresid process employed catalyst particles of "granular size" (much larger than conventional FCC catalyst particle size) in a compact gravitating bed, rather than suspending catalyst particles in feed and product vapors in a fluidized  
30 catalyst bed system. The productivity of the process, compared to fluid catalytic cracking with lighter gas oils, was low. But the Houdresid process did offer some advantages. It appeared that the adverse effects

previously encountered with heavy metals in the feed were not as great a barrier in the Houdresid process as one might expect in FCC processing. The heavy metal which accumulated on or near the outer surfaces of the catalyst particles apparently could be removed to some extent by an attrition process, which selectively removed an outer layer of metal-contaminated catalyst. The catalysts were very cheap, but also relatively inactive, and highly unsuitable by today's standards. While the maximum tolerable limit of heavy metal contamination on catalyst in fluid catalytic cracking was then thought to be about 200 parts per million, the Houdresid process did continue to operate satisfactorily even when the total nickel plus vanadium content of the catalyst had reached 870 ppm. Moreover, it was found that the required levels of product selectivity could be maintained without withdrawing catalyst from the process, except to the extent that withdrawal was required by normal mechanical losses (e.g. attrition and inadvertent discharge with off gases) and by the attrition and inadvertent discharge with off gases) and by the attrition method used to control metals level. Today, such attrition of catalyst to fine particulates would present an expensive environmental problem, thus considerably increasing difficulties involved in practicing the process.

Although the Houdresid process obviously represented a step forward in dealing with the effects of metal contamination and coke formation on catalyst performance, its productivity was limited. Thus, for the many years which have passed since the Houdresid process was first introduced commercially, the FCC process art has continued an arduous search for suitable

modifications or alternatives to the FCC process which would permit commercially successful operation on reduced crude and the like. During this operating and search period a number of proposals have been made; some have  
5 been used commercially to a certain limited extent.

Several proposals involve treating a heavy or high boiling oil feed to remove the metal therefrom prior to cracking, such as by hydrotreating, solvent extraction  
10 and/or complexing with Friedel-Crafts catalysts, but these techniques have been criticized as unjustified economically. Another proposal employs a combination cracking process having "dirty oil" and "clean oil" processing units. Still another proposal blends residual  
15 oil with gas oil and controls the quantity of residual oil in the mixture in relation to the equilibrium flash vaporization temperature at the bottom of the riser type cracker unit employed in the process. Still another proposal subjects the feed to a mild preliminary  
20 hydrocracking or hydrotreating operation before it is introduced into the cracking unit. It has also been suggested to contact a carbometallic oil such as reduced crude with hot taconite pellets to produce gasoline. This is only a small sampling of many proposals which  
25 have appeared in the patent literature and technical reports for upgrading carbometallic oil feeds.

Notwithstanding the great effort which has been expended and the fact that each of these proposals  
30 overcomes some of the difficulties involved, conventional FCC practice today bears mute testimony to the dearth of carbometallic oil-cracking techniques that are both economical and highly practical in terms of technical

feasibility. Some crude oils are relatively free of substantial coke precursors or heavy metal contaminants or both, and the most troublesome components of crude oil are for the most part concentrated in the highest boiling fractions thereof. It has been possible in the prior art to largely avoid the problems of coke precursors and heavy metals by sacrificing the liquid fuel yield which would be potentially available from the highest boiling fractions. More particularly, conventional FCC practice has employed as a part of the gas oil feedstock that fraction of crude oil which boils at about 650°F to about 1000°F, such fractions being relatively free of heavy metal contamination. Such feedstock, known as "vacuum gas oil " (VGO) is generally prepared from crude oil by distilling off the fractions boiling below about 650°F at about atmospheric pressure and then separating by further vacuum distillation from the heavier fractions a vacuum gas oil cut boiling from about 650°F up to about 900°F or 1025°F.

20

A gas oil of atmospheric distillation in combination with vacuum gas oil is most often used as feedstock for prior art conventional FCC processing. The heavier fractions of the crude oil are normally employed for a variety of other purposes, such as for instance production of asphalt, residual fuel oil, #6 fuel oil, or marine Bunker C fuel oil, which represents a great waste of the potential value of this portion of the crude oil. This is especially true in light of the great effort and expense which the art has been willing to expend in the attempt to produce generally more suitable feed materials from coal and shale oils.

30

The present invention is particularly aimed at the cracking of gas oils with or without the heavier fractions of crude oils and particularly that portion thereof containing substantial quantities of both coke precursors, heavy metals, and other troublesome components either alone or in conjunction with the lighter more suitable oils, thereby potentially increasing the overall yield of gasoline and other desired gaseous and liquid fuels from a given crude oil.

It is believed that the method and means comprising the process of this invention is uniquely advantageous for dealing with the problem of treating gas oils with and without high boiling carbometallic oils in an economically and technically sound manner.

In general, the coke-forming tendency or coke precursor content of an oil can be ascertained by determining the weight percent of the carbon remaining after a sample of that oil has been pyrolyzed. The industry accepts this value as a measure of the extent to which a given oil tends to form non-catalytic coke when employed as feedstock in a catalytic cracker. Two established tests are recognized, the Conradson Carbon and Ramsbottom Carbon Tests, the latter being described in ASTM Test No. D524-76. In conventional FCC practice, Ramsbottom carbon values on the order of about 0.1 to about 1.0 are regarded as indicative of acceptable feed. The present invention is concerned with the use of hydro-carbon feedstocks which have higher Ramsbottom carbon values and thus exhibit substantially greater potential for coke formation than the usual feeds.



Since the various heavy metals are not of equal catalyst poisoning activity, it is convenient to express the poisoning activity of an oil containing a given poisoning metal or metals in terms of the amount of a single metal which is estimated to have equivalent poisoning activity. Thus, the heavy metals content of an oil can be expressed by the following formula (patterned after that of W. L. Nelson in Oil and Gas Journal, page 143, October 23, 1961) in which the content of each metal present is expressed in parts per million of such metal, as metal, on a weight basis, based on the weight of feed.

$$\text{Nickel Equivalents} = \text{Ni} + \frac{\text{V}}{4.8} + \frac{\text{Fe}}{7.1} + \frac{\text{Cu}}{1.23}$$

According to conventional FCC practice, the heavy metal content of a feedstock for FCC processing is controlled at a relatively low level, e.g. about 0.25 ppm Nickel Equivalents or less. The present invention is concerned with the processing of feedstocks containing metal contaminants substantially in excess of this value, and which therefore have a significantly greater potential for accumulating on and poisoning catalyst.

The above formula can also be employed as a measure of the accumulation of heavy metals on cracking catalyst, except that the quantity of metal employed in the formula is based on the weight of catalyst (moisture free basis) instead of the weight of feed. In some known FCC prior art processes, in which a circulating inventory of catalyst is used again and again in the processing of fresh feed, with periodic and/or continuing minor addition and withdrawal of fresh and spent catalyst, the

metal content of the catalyst is maintained at a level which may for example be in the range of about 200 to about 6000 ppm Nickel Equivalents. The process of the present invention is concerned with the use of catalyst  
5 having an accumulated large metals content, and which therefore has the potential in the absence of controls to promote dehydrogenation, aromatic condensation, gas production or coke formation.

10

#### SUMMARY OF THE INVENTION

The present invention is concerned with the catalytic conversion of crude oils known as residual oils and/or resids recovered as the bottoms products of  
15 atmospheric and/or vacuum distillation and containing substantial quantities of coke precursors and heavy metal contaminants, sulfur and nitrogen compounds. Sodium found in crude oil is also a troublesome component in deactivating particularly a crystalline zeolite cracking  
20 catalyst. Thus the combination method and process of this invention is a unique sequence of operating parameters designed to dispose of and/or handle undesirable components comprising a residual oil or a reduced crude in a manner permitting substantial  
25 conversion of high boiling hydrocarbon components in association therewith to more desirable gaseous and liquid fuel products and particularly those in the gasoline boiling range.

30

The combination of unique steps contributing to the novel combination of this invention represents a highly specialized and productive approach to the conversion and recovery of the product of catalytic

conversion of high boiling residual oil feedstocks comprising carbometallic feed components such as found in topped crudes, residual oils, reduced crudes and resids. A petroleum crude oil and particularly the 650°F plus  
5 portion thereof is characterized in the absence of further treatment as having a heavy metals content of at least about 5 ppm up to 50 ppm of Ni equivalents by weight and a carbon residue on pyrolysis of at least about 1% by weight.

10

Some hydrocarbon feeds which may be processed in the combination operation of this invention are specifically identified in Table 1 below.

15

This application is directed to improvements and different operating embodiments over that of copending application Serial No. 6/304992 (Attorney Docket No. 6107B) the subject matter of which application is incorporated herein by reference thereto.

20

TABLE 1

| Oil or Crude       | API Grav.<br>650° (2)<br>Total | Volume<br>% of 650+<br>Fraction<br>Boiling at |       | Ramsbottom<br>Carbon Content |       | Wt. ppm<br>Metals (3) |       |      |              | Wt. %<br>S in<br>650+<br>Total | Weight of<br>Nitrogen (ppm) |       | Wt.<br>ppm<br>Na |
|--------------------|--------------------------------|-----------------------------------------------|-------|------------------------------|-------|-----------------------|-------|------|--------------|--------------------------------|-----------------------------|-------|------------------|
|                    |                                | 650-<br>1025                                  | 1025+ | 650-<br>1025                 | 1025+ | Ni                    | V     | Fe   | Ni<br>Equiv. |                                | 650+ Fraction<br>Total      | Basic |                  |
| VGO                | 28.4                           | 100                                           | 0.0   | 0.38                         | 0.38  | 0.2                   | 0.1   | 2.6  | .059         | .03                            | 722                         | 260   | 0.0              |
| Mexican Isthmus    | 16.9<br>(21.3)                 | 65.3                                          | 34.7  | 0.49                         | 4.96  | 2.5+                  | 33.0  | 1.9  | 9.01         | 2.75                           | 950                         | 450   | 6.9              |
| Mexican Kirkuk (1) | 17.4                           |                                               |       |                              | 9.30  | 35.0                  | 99.0  | 17.0 | 58.02        | 2.94                           | 2100                        | 723   | 1.0              |
| Murban             | 23.1                           | 78.7                                          | 21.3  | 0.49                         | 3.99  | 3.0+                  | 1.5   | 11.9 | 4.99         | 1.64                           | 512                         | 200   | 7.5              |
| Arabian Light      | 19.1                           | 64.7                                          | 35.3  | 0.47                         | 6.56  | 6.4                   | 24.7  | 3.2  | 12.00        | 2.39                           | 940                         | 507   | 9.2              |
| Arabian Med.       | 14.5                           | 51.8                                          | 48.2  | 0.46                         | 9.00  | 19.6                  | 63.0  | 2.9  | 33.13        | 4.43                           |                             |       |                  |
| Ehofisk            | 22.7                           | 72.8                                          | 27.2  | 0.36                         | 4.42  | 1.4                   | 3.0   | 2.4  | 2.36         | 0.38                           |                             |       |                  |
| Posterton          | 10.9                           | 43.6                                          | 56.4  | 0.42                         | 16.81 | 48.8                  | 119.0 | 3.1  | 74.03        | 4.22                           |                             |       |                  |
| Iranian Light      | 17.4                           | 60.8                                          | 39.2  | 0.48                         | 9.01  | 21.9                  | 60.0  | 3.1  | 34.84        | 2.50 (4)                       |                             |       |                  |
| La./Miss Sweet     | 23.7                           | 80.2                                          | 19.8  | 0.33                         | 4.36  | 2.7+                  | --    | 8.5  | 3.90         | 0.26                           |                             |       |                  |
| Wyoming Sour       | 12.4                           | 40.7                                          | 59.3  | 0.32                         | 15.1  | 0.6                   | 70.0  | 2.0  | 15.47        | 3.84                           |                             |       |                  |

(1) A refinery blend of Mexican and Kirkuk crudes.

(2) Throughout the table 650 and 1025 refer to 650°F and 1025°F respectively; 650+ refers to 650°F+ material as defined below.

(3) Copper level was below 0.5t, except that Mexican Kirkuk contained 0.6t; all metals expressed as metal in ppm, based on the weight of the 650+ fraction.

(4) Calculated.

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### BRIEF DESCRIPTION OF THE DRAWINGS

Figure I is a diagrammatic sketch in elevation of a riser reactor design and suspension separation means at the riser open upper end housed within a collector-stripper vessel for separated fluidizable solid particulates.

Figure II is a diagrammatic sketch in elevation of the riser bottom arrangement for introducing more than one or more gasiform materials as reactant or lift gaseous material.

Figure III is an end view diagrammatic sketch in elevation of an "L" shaped fluid material inlet means particularly showing slot passageways in the upper wall periphery and arranged to direct fluid material only to the inside of a riser contact means.

Figure IV is a top view of the segmented open upper end of the "L" shaped inlet means of figure III.

### DISCUSSION OF SPECIFIC EMBODIMENTS

Referring now to figure I by way of example, there is shown a riser reactor 2 embodiment which departs from riser reactor 50, figure V of the above referenced copending application by providing an initial catalyst suspension forming lift section "A" employing one or a combination of left gasiform materials such as a relatively inert lift gas such as steam, a wet gaseous product of thermal and/or catalytic cracking, either one of which is used alone or in conjunction with a

low-quality naphtha product available to the process for catalytic upgrading such as a naphtha product of thermal cracking, coking, etc.

5           The riser reactor 2 is provided above section  
"A" with an expanding transition section 4 which  
terminates in a larger diameter riser section there above  
and in which conversion of a residual oil feed is  
particularly effected. The expanded portion of riser 2  
10 is provided with a plurality of feed inlet nozzles 6  
adjacent the upper edge of the transition section which  
penetrates the riser wall and are of a configuration  
particularly identified with figures III and IV more  
fully discussed below. In addition, oil feed inlet  
15 nozzles 8 are provided in a more down stream portion of  
the riser 2 thereby permitting more limited contact time  
between catalyst particles and oil feed within the riser  
before separating a formed suspension thereof. Thus, the  
riser 2 configuration of this invention permits  
20 relatively high temperature zeolite catalytic upgrading  
of thermal naphtha in a bottom portion of the riser with  
or without the presence of lift gas such as steam or a  
wet gaseous product of the combination operation or  
obtained from either thermal or catalytic cracking and  
25 comprising some C<sub>5</sub> and lower boiling hydrocarbons as well  
as up to 10 or 15% by weight of process produced  
hydrogen. In addition, the oil feed inlet means or  
nozzles 6 and 8 permit substantial variation in contact  
time between oil feed and catalyst depending on which  
30 feed nozzles employed and suspension velocity employed in  
the riser. Generally speaking contact time between a  
residual of feed and catalyst in the riser and depending  
on composition and source will be restricted to within

the range of 0.5 to 5 seconds and more usually 3 seconds or less. In this operating environment it is contemplated charging catalyst particles to the riser bottom at a temperature within the range of 1300°F to 1600°F and in an amount sufficient to provide a desired catalyst to oil ratio and permit recovering hydrocarbons in the suspension from the riser discharge at a temperature within the range of 950°F up to about 1100°F. Vaporous hydrocarbons separated from suspended catalyst particles at the riser discharge, preferably in the manner discussed below, are further separated and recovered much in the same manner as that disclosed in figure VII of the above identified copending application except as modified by the discussion below.

It will be recognized by those skilled in the fluid catalyst art, that the riser reactor 2 may be substantially any vertical length which will be compatible with an adjacent catalyst regeneration operation, catalyst stripping operation and conduit catalyst transfer means essential to the process whether the same or departing from that shown in the copending application above identified.

In the specific arrangement of figure I, the upper portion of riser 2 passes upwardly through and is coaxially aligned with an annular stripping section, open in the upper portion thereof with a vessel section 12 generally encompassing the upper discharge end of the riser reactor. Vessel section 12 confines catalyst particles separated from hydrocarbon vaporous products for transfer and settling downwardly into the annular stripping section 10. Stripping gas such as steam or

other suitable gas is charged to a lower bottom portion of the stripping zone by conduit means 14 for flow upwardly through and countercurrent to downwardly flowing catalyst particles over a plurality of annular baffle members shown.

A most important aspect of the riser system of this invention is particularly directed to the method and means for separating the upwardly flowing suspension at the riser upper open end in a highly efficient manner. That is to say, the suspension in riser 2 is discharged from its upper open end at a velocity which will impart greater momentum to the particles of catalyst than to that imparted to the vaporous hydrocarbon products whereby the upward trajectory of the catalyst particles will separate themselves substantially from gasiform materials comprising vaporous hydrocarbon of catalytic conversion and separation of such gasiform material will be further enhanced by establishing a vapor or gasiform material withdrawal passageway of reduced internal pressure adjacent the upper open end of the riser reactor.

Separating the catalyst so discharged from the riser from recontact with hydrocarbon vapor may be enhanced considerably by providing a concave impingement surface spaced above the riser outlet which is located a distance at least equal to the riser diameter and more preferably is from 1.5 to 2 times the riser diameter above the riser outlet. This concave impingement surface may be an upper head portion of vessel 12, a separate dish-shaped baffle means or a baffle arrangement



comprising two half circular sections representing gull wings in cross section.

5       The velocity of the discharged suspension may  
vary over a relatively wide range depending upon the  
diameter of the riser discharge opening. It is  
important, however, that the mass-velocity component  
(momentum) of the hydrocarbon vapors should not be so  
10       high as to preclude achieving the separation desired.  
Suspension velocities at the riser discharge opening over  
the range of 50 to 100 feet per second have been found  
generally satisfactory with more optimum conditions  
permitting a separation of catalyst from hydrocarbon  
vapors up to about 90 percent.

15       In the specific arrangement of figure I, an  
annular cup means 16 open in the upper surface thereof  
adjacent the riser discharge opening, collects vapors for  
passage to cyclone 18 attached thereto by suitable  
20       confined passageway means. Vapors separated from  
entrained catalyst fines are removed by conduits 20  
communicating with plenum 22 and withdrawal conduit 24.  
Catalyst fines separated in cyclones 18 are moved by  
diplegs 26 for passage to the annular stripping zone as a  
25       downwardly moving fluid bed of catalyst particles.  
Catalyst particles stripped in annular section 10 are  
withdrawn by conduit 28 for passage to a catalyst  
regeneration operation such as shown in the copending  
application above identified or other suitable catalytic  
30       regeneration arrangement to remove carbonaceous deposits  
of riser hydrocarbon conversion by combustion with oxygen  
containing gas.

It is contemplated modifying the arrangement of figure II to provide a smaller diameter vessel 12 and hanging cyclones 18 outside the vessel rather than inside as shown in the figure. On the other hand, it is also contemplated in some specific embodiments of eliminating the cyclones shown and recovering any entrained solid fines with vapors passed to a rough cut separation zone for recovery by liquid oil and separation by decantation for further use or disposal as required or desired.

It will be further recognized by those skilled in the art that the riser arrangement above discussed lends itself to other operating variations which include processing a lower boiling portion of crude oil comprising gas oils by injection by feed inlet means 6 and injecting a higher boiling portion of the crude oil by feed inlet means 8. It is also contemplated providing a third feed inlet means to riser 2 adjacent the bottom edge of the stripping zone whereby a topped crude or a residual portion of a crude oil may be introduced including vacuum gas oils and higher boiling materials comprising carbometallic impurities.

The hydrocarbon conversion operations contemplated to be accomplished in the riser arrangement of this invention rely upon the use of fluid particles of catalyst of a particle size in excess of 10 microns and providing an average particle size within the range of about 65 to about 90 and more usually not more than about 80 or 85 microns. The catalyst is preferably one comprising a crystalline aluminosilicate or crystalline zeolite activated by rare earth exchange and dispersed in a matrix materials which may or may not have catalytic

activity. A catalyst particularly suitable is a rare earth exchanged faujasite crystalline zeolite containing catalyst of a pore volume and matrix pore size openings which will collect and accumulate substantial quantities of metal contaminants and yet retain substantial catalyst cracking activity and selectivity. In this catalyst metals accumulation environment, it is contemplated adding atomizing or emulsion forming or both quantities of water with the feed and preferably process recovered sour water comprising sulfur compounds which can effect some passivation of metal components in the feed comprising nickel, vanadium, iron, and copper as major components. Thus, a residual oil portion of crude oil or any portion thereof charged to feed nozzle 6 may be mixed with process recovered sour water charged by conduit 30 or by conduits 32 to oil feed charged to feed nozzles 8.

Figure II relates particularly to the bottom portion of section "A" of riser 2 to which lift gas is added with or without naphtha addition as briefly identified above. In this figure, lift gas such as steam or a wet gaseous product of hydrocarbon conversion is charged by conduit 34 to a coaxially positioned cylindrical means 36 of smaller diameter than said riser 2. This cylindrical means 36 is perforated in its upper surface 38 for flow of gaseous material therethrough. In addition, the upper periphery of the cylinder is provided with a double row of openings 40 through which fluidizing gaseous material is passed to form a suspension with catalyst particles charged to the riser by standpipe means 42. Nozzle means 42 are provided for separately charging low quality naphtha when desired to a bottom portion of the riser. These nozzles means comprising

about 6 nozzles positioned about cylindrical member 36 may discharge generally vertically upward as shown or they may be sloped slightly inward.

5                Figures III and IV are particularly concerned  
with the "L" shaped oil feed inlet means 6 or 8 briefly  
discussed above. Figure III is an end view of the nozzle  
as viewed from inside the riser and shows a plurality of  
10 elongated slot passageways in the upper periphery thereof  
for directing charge oil towards the inside of the riser  
for distribution contact with upflowing catalyst  
suspended in wet gas product discussed above. Figure IV  
shows the top surface of the "L" shaped nozzle conduit  
15 segmented with a plate means 40 provided with openings 42  
through which the oil feed is charged for dispersion  
contact with upflowing particles of catalyst. Thus when  
employing a plurality of the pipe nozzles of figures III  
and IV penetrating the wall of riser 2 and equally spaced  
from one another, it is evident that the nozzles will  
20 discharge upwardly and into the riser for contact with an  
upwardly flowing catalyst suspension formed as herein  
provided. An opening 44 may or may not be formed in  
member 40 as desired. The open area of slots 38 may be  
equal to or less than the combined open area in the top  
25 of the pipe nozzle represented by opening 42.

              In a specific operating embodiment, it is  
contemplated forming a suspension of hot regenerated  
catalytically active faujasite zeolite containing  
30 cracking catalyst admixed with wet gaseous product of the  
process comprising  $C_5$  and lower boiling hydrocarbons  
comprising up to 15 percent hydrogen and up to 10% water.  
This formed high temperature suspension is passed at a

relatively low velocity upwardly through section "A" of the riser before entering the expanded riser section for contact with residual oil feed under hydrocarbon conversion conditions selected to produce gasoline precursors, gasoline and higher boiling light cycle oil. Charging the oil feed by inlet conduit 6 will provide a relatively long hydrocarbon residence time in the downstream portion of the riser up to about 2 seconds. However, charging the oil feed by inlet means 8 will severely limit the riser contact time to less than 1 second and as low as 0.5 seconds. It will be further recognized that the riser arrangement of figure I may also be employed in the thermal visbreaking operation of the above identified copending application and modified to delete the naphtha charge nozzles particularly discussed with respect to figure II.

Having thus generally discussed the method and means of this invention and described specific embodiments contributing to the improvements of this invention, it is to be understood that no undue restrictions are to be imposed by reasons thereof except as defined by the following claims:

We claim:

1. In a combination operation for upgrading crude oils and residual portions of crude oils comprising carbometallic impurities to produce gasoline and lower boiling components the improvement which comprises:
  - A. forming a suspension of hot regenerated catalyst particles at a temperature in the range of 1300 to 1600°F in a wet gaseous product of catalytic conversion comprising C<sub>5</sub> and lower boiling components;
  - B. contacting the suspension thus formed with a residual portion of crude oil admixed with sour water for a hydrocarbon residence time in a riser reaction zone for a time period in the range of 0.5 up to about 6 seconds and sufficient to provide vaporous products comprising substantial yields of gasoline boiling range components;
  - C. initially separating said suspension with vaporous products by imparting a greater momentum to said catalyst particles than said hydrocarbon vapors; substantially enhancing the separation of hydrocarbon vapors from catalyst particles of greater momentum by establishing a confined region of reduced pressure adjacent a zone of

hydrocarbon vapors separated from catalyst particles by momentum differential; and

- 5 D. withdrawing hydrocarbon vapors from said confined region of reduced pressure free of substantial catalyst particle entrainment.
- 10 2. The method of claim 1 wherein said vaporous hydrocarbons are passed from said reduced region to a cyclone separation zone before recovery and separation into desired components.
- 15 3. The method of claim 1 wherein a low quality naphtha product initially contacts said catalyst for crystalline zeolite upgrading of said naphtha before contacting said residual oil.
- 20 4. The method of claim 1 wherein said cyclone separation zones are located within or outside a catalyst collecting and stripping zone about the upper end of said riser reaction zone.
- 25 5. The method of claim 1 wherein the residual oil feed admixed with sour water is charged to said riser reactor zone for discharge there above a transition section to a larger diameter riser reaction zone.
- 30 6. The method of claim 1 wherein the residual oil feed is charged to the riser below the

discharge end thereof a distance sufficient to restrict the hydrocarbon residence time therein to within the range of 0.5 to 1.5 seconds.

- 5           7.   The method of claim 1 wherein the residual oil  
            feed charged to the riser reaction zone is by  
            on "L" shaped nozzles provided with a plurality  
            of separate open passageways in its discharge  
10           cross-section area and an inside wall portion  
            of the nozzle wall adjacent its discharge end.
8.   The method of claim 1 wherein the riser  
            reaction zone is provided with a plurality of  
15           horizontally spaced apart "L" shaped nozzles  
            penetrating the riser wall in one or more  
            locations selected from a transition section  
            increasing the riser diameter, substantially  
            adjacent the bottom of the annular stripping  
20           zone through which the riser passes and in the  
            upper portion of the riser reaction zone and  
            above the upper limits of a catalyst bed  
            entering the annular stripping zone.
9.   A method for selectively converting a residual  
25           oil portion of crude oil comprising  
            metallo-organic compounds, sulfur and nitrogen  
            which comprises; initially forming a suspension  
            of hot regenerated zeolite containing  
            hydrocarbon conversion catalyst with a normally  
30           gaseous hydrocarbon catalytic conversion  
            product comprising water and hydrogen;  
            contacting said catalyst suspension with a  
            residual oil feed emulsified with a sour water



5           overhead product of said residual oil  
conversion operation at a hydrocarbon  
conversion temperature and for a time in the  
range of 0.5 up to about 3 seconds in a riser  
contact zone; separating the suspension upon  
discharge from the riser contact zone by  
establishing a momentum differential between  
particles of catalyst and hydrocarbon vapors  
and providing a reduced pressure annular vapor  
10       withdrawal zone about a high momentum catalyst  
stream which attracts vaporous hydrocarbons to  
the substantial exclusion of catalyst  
particles, and separately recovering catalyst  
particles and hydrocarbon vapors thus  
15       separated.

FIG. I

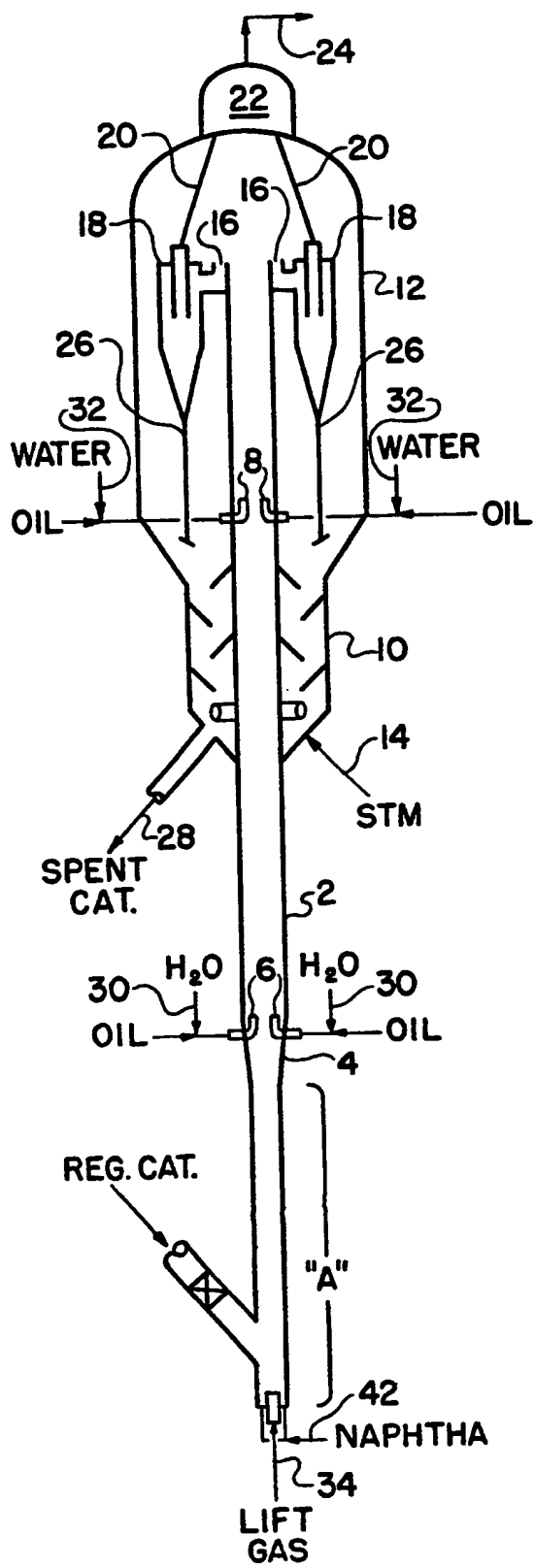


FIG. IV

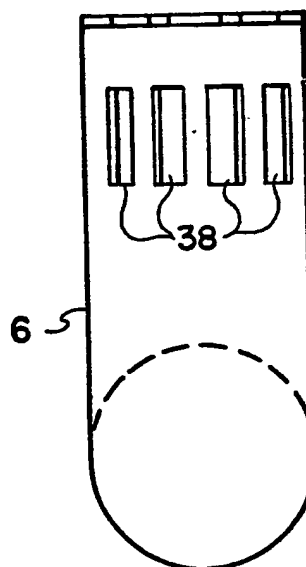
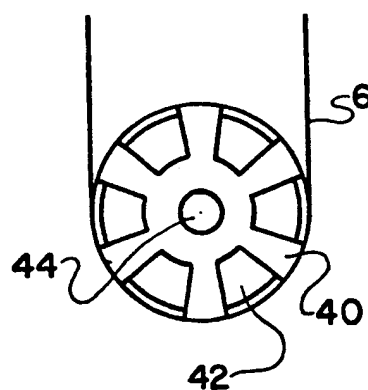
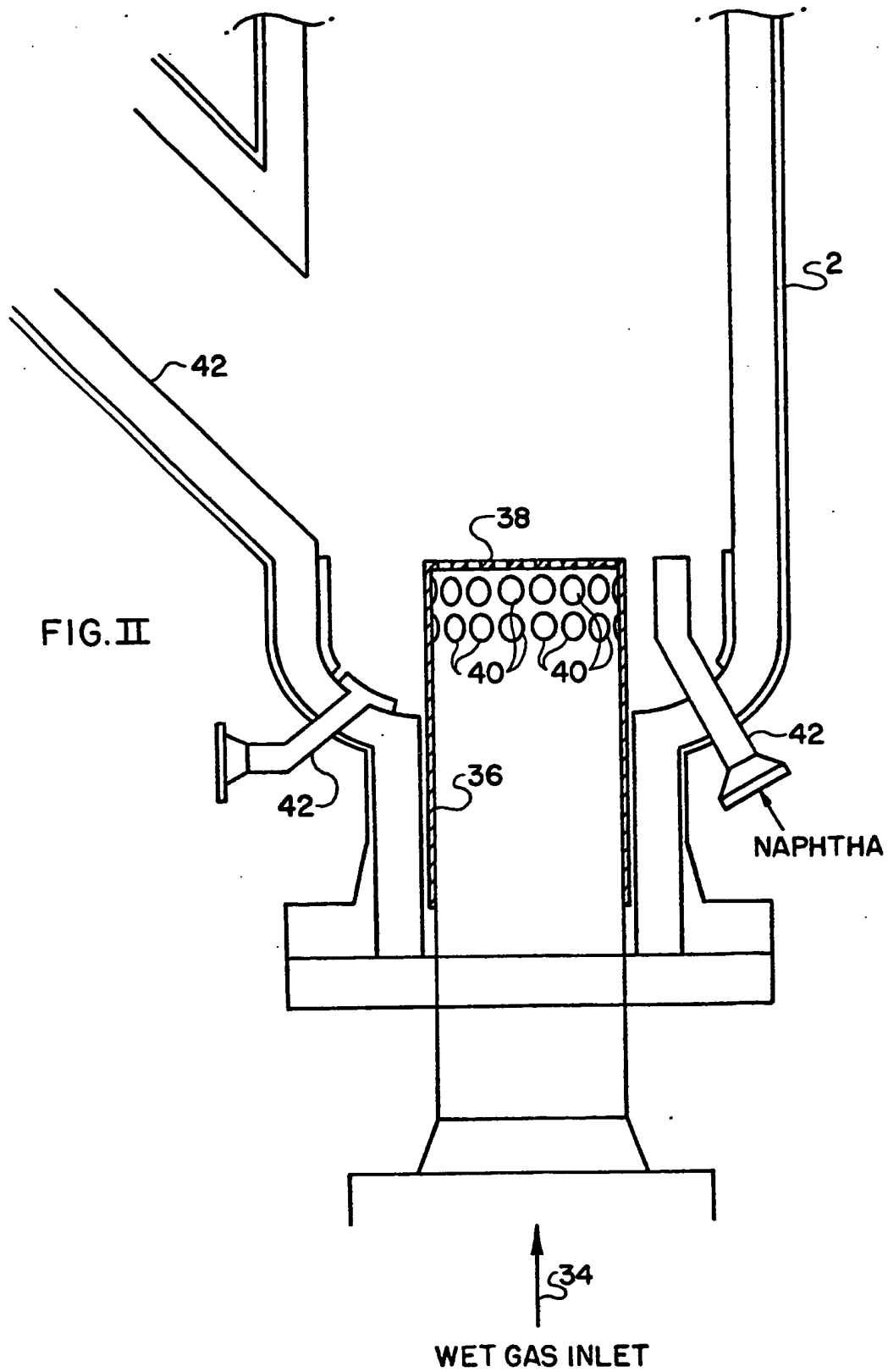



FIG. III





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 Method and apparatus for converting oil feeds.


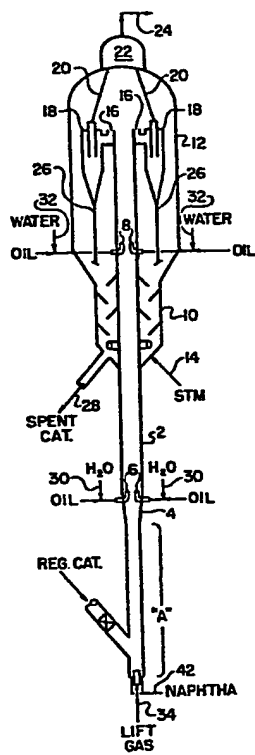
 Novel riser reactor design with associated multiple feed inlet means for contacting regenerated catalyst particles with low quality naphtha, C<sub>5</sub> minus wet gas product of hydrocarbon conversion and a residual oil feed comprising components boiling above about 1025°F and comprising metal contaminants. Low quality naphtha from thermal cracking is charged either separately or in admixture with C<sub>5</sub> and lower boiling wet gas product of hydrocarbon conversion to the bottom portion of the riser conversion zone for contact with freshly regenerated zeolite cracking catalyst. The vaporous material thus charged conveys the regenerated catalyst at an acceptable velocity to an expanded section of the riser wherein residual oil is charged by a plurality of nozzle means penetrating the wall of the riser in the transition section to the expander user section. A suspension of hydrocarbon vapors and catalyst particles is then passed through the riser discharge for a desired contact time before separation by ballistic separation with a cup about the riser upper to the riser end.

FIG. 1





European Patent  
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# EUROPEAN SEARCH REPORT

0101553

Application number

EP 83 10 6610

| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                     |                                                                                                               |                                                                                                                                                                                                                                                                              |                                                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|
| Category                                                                                                                                                                                                                | Citation of document with indication, where appropriate, of relevant passages                                 | Relevant to claim                                                                                                                                                                                                                                                            | CLASSIFICATION OF THE APPLICATION (Int. Cl. 3) |
| P,X                                                                                                                                                                                                                     | WO-A-8 204 063 (ASHLAND OIL)<br>* Claims 1-23; figures 1,2; page 91, last paragraph; page 92, above page 95 * | 1-9                                                                                                                                                                                                                                                                          | C 10 G 11/18<br>B 01 J 8/24<br>C 10 G 47/30    |
| Y                                                                                                                                                                                                                       | ---<br>US-A-4 268 416 (STINE et al.)<br>* Claims 1,6,7 *                                                      | 1-9                                                                                                                                                                                                                                                                          |                                                |
| Y                                                                                                                                                                                                                       | ---<br>GB-A-2 063 295 (ASHLAND OIL)<br>* Figures 1,2; claim 1 *                                               | 1-9                                                                                                                                                                                                                                                                          |                                                |
| A                                                                                                                                                                                                                       | ---<br>US-A-4 280 895 (STUNTZ et al.)<br>* Claims 1-10 *                                                      |                                                                                                                                                                                                                                                                              |                                                |
| A                                                                                                                                                                                                                       | ---<br>US-A-4 376 038 (MYERS)<br>* Figures 1,2; claims *                                                      |                                                                                                                                                                                                                                                                              |                                                |
|                                                                                                                                                                                                                         |                                                                                                               |                                                                                                                                                                                                                                                                              | TECHNICAL FIELDS SEARCHED (Int. Cl. 3)         |
|                                                                                                                                                                                                                         |                                                                                                               |                                                                                                                                                                                                                                                                              | C 10 G<br>B 01 J                               |
| The present search report has been drawn up for all claims                                                                                                                                                              |                                                                                                               |                                                                                                                                                                                                                                                                              |                                                |
| Place of search<br>THE HAGUE                                                                                                                                                                                            |                                                                                                               | Date of completion of the search<br>29-02-1984                                                                                                                                                                                                                               | Examiner<br>MICHIELS P.                        |
| CATEGORY OF CITED DOCUMENTS                                                                                                                                                                                             |                                                                                                               | T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>& : member of the same patent family, corresponding document |                                                |
| X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document |                                                                                                               |                                                                                                                                                                                                                                                                              |                                                |

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